first stage, m $(r_1 * r_2)$ switches MS1-MSm in the middle stage, and r_2 $(m * n_2)$ switches OS1-OSr_2 in the last stage where $N_1 = n_1 * r_1$ is the total number of inlet links and $N_2 = n_2 * r_2$ is the total number of outlet links of the network. Each of the m switches MS1-MS(2*n_1+n_2-1) are connected to each of the input switches through r_1 first internal links (for example the links FL11-FL$r_1$1 connected to the middle switch MS1 from each of the input switch IS1-ISr_1), and connected to each of the output switches through r_2 second internal links (for example the links SL11-SL$r_2$1 connected from the middle switch MS1 to each of the output switch OS1-OSr_2). Such a multi-stage switching network is denoted as a $V(m,n_1,r_1,n_2,r_2)$ network. For the special symmetrical case where $n_1 = n_2 = n$ and $r_1 = r_2 = r$, the three-stage network is denoted as a $V(m,n,r)$ network. In general, the set of inlet links is denoted as $\{1,2,...,r_1 n_1\}$ and the set of output switches are denoted as $O = \{1,2,...,r_2\}$. In an asymmetrical three-stage network, as shown in FIG. 2B with n_1 inlet links for each of r_1 input switches, n_2 outlet links for each of r_2 output switches, no more than $2 * n_1 + n_2 - 1$ middle stage switches are necessary for the network to be strictly nonblocking, again when using the scheduling method of FIG. 1B. The network has all connections set up such that each connection passes through at most two middle switches to be connected to all destination outlet links.

Every switch in the multi-stage networks discussed herein has multicast capability. In a $V(m,n_1,r_1,n_2,r_2)$ network, if a network inlet link is to be connected to more than one outlet link on the same output switch, then it is only necessary for the corresponding input switch to have one path to that output switch. This follows because that path can be multicast within the output switch to as many outlet links as necessary. Multicast assignments can therefore be described in terms of connections between input switches and output switches. An existing connection or a new connection from an input switch to r' output switches is said to have fan-out r'. If all multicast assignments of a first type, wherein any inlet link of an input switch is to be connected in an output switch to at most one outlet link are realizable, then multicast assignments of a second type, wherein any inlet link of each input switch is to be connected to more than one outlet link in the same output switch, can also be realized. For this reason, the following discussion

is limited to general multicast connections of the first type (with fan-out r', $1 \leq r' \leq r_2$) although the same discussion is applicable to the second type.

To characterize a multicast assignment, for each inlet link $i \in \{1,2,...,r_1 n_1\}$, let $I_i = O$, where $O \subset \{1,2,...,r_2\}$, denote the subset of output switches to which inlet link i is to be connected in the multicast assignment. For example, the network of Fig. 1A shows an exemplary three-stage network, namely $V(8,3,4)$, with the following multicast assignment $I_1 = \{1,2\}$, $I_2 = \{1,3,4\}$, $I_6 = \{3\}$ and all other $I_j = \phi$ for j = [1-12]. It should be noted that the connection I_1 fans out in the first stage switch IS1 into the middle stage switches MS1 and MS2, and fans out in middle switches MS1 and MS2 only once into output switches OS1 and OS2 respectively. The connection I_1 also fans out in the last stage switch OS1 once into outlet link OL1 and in the last stage switch OS2 into the outlet links OL4, OL5 and OL6. The connection I_2 fans out once in the input switch IS1 into middle switch MS4 and fans out in the middle stage switch MS4 into the last stage switches OS1, OS3 and OS4. The connection I_2 fans out once in the output switches OS1, OS3, and OS4 into outlet links OL2, OL7, and OL12 respectively. The connection I_6 fans out once in the input switch into middle switch MS3, fans out in the middle switch MS3 once into output switch OS3, fans out once in the output switch into outlet link OL9. In accordance with the invention, each connection can fan out in the first stage switch into at most two middle stage switches, and in the middle switches and last stage switches it can fan out any arbitrary number of times as required by the connection request.

Two multicast connection requests $I_i = O_i$ and $I_j = O_j$ for $i \neq j$ are said to be compatible if and only if $O_i \cap O_j = \phi$. It means when the requests I_i and I_j are compatible, when the inlet links i, j do not belong to the same input switch, they can be set up through the same middle switch.

FIG. 3A is intermediate level flowchart of one implementation of the method of FIG. 1B. In the following "destination switch" or "destination" refers to any switch in the output stage 120 that is identified in a connection request. According to this

implementation, a connection request is received in act 141. Then the method 140 checks in act 142 if the connection can be set up through only one middle switch and if act 142A finds a middle switch which has second internal links to all the destinations available then the connection is set up in act 142C and the control returns to act 141. If act 142A results in "no", the control goes to act 142B where the method 140 finds two middle switches through which the connection can be set up. Then the control goes to act 142C, where act 142C sets up the connection through the two middle switches. Therefore no more than two middle switches are used when attempting to satisfy the connection request. When the connection is set up in 142C, control returns to act 141 so that acts 141 and 142 are executed in a loop, for each connection request all the middle switches until the connection is set up.

TABLE 1
A Multicast assignment in a $V(8,3,9)$ Network

Requests for r = 1	Requests for r = 2	Requests for r = 3
$I_1 = \{1,2,3\}$,	$I_4 = \{1,4,7\}$,	$I_7 = \{1,5,9\}$,
$I_2 = \{4,5,6\}$,	$I_5 = \{2,5,8\}$,	$I_8 = \{2,6,7\}$,
$I_3 = \{7,8,9\}$,	$I_6 = \{3,6,9\}$,	$I_9 = \{3,4,8\}$

Table 1 above shows a multicast assignment in $V(8,3,9)$ network. This network has a total of twenty-seven inlet links and twenty-seven outlet links. The multicast assignment in Table 1 shows nine multicast connections, three each from the first three input switches. Each of the nine connections has a fan-out of three. For example, the connection request I_1 has the destinations as the output switches OS1, OS2, and OS3 (referred to as 1, 2, 3 in Table 1). Request I_1 only shows the output switches and does not show which outlet links are the destinations. However it can be observed that each output switch is used only three times in the multicast assignment of Table 1, using all the three outlet links in each output switch. For example, output switch 1 is used in requests I_1, I_4, I_7, so that all three outlet links of output switch 1 are in use, and a specific identification of each outlet link is irrelevant. And so when all the nine connections are set up all the twenty-seven outlet links will be in use.